Abstract

The effective ionic conductivity in a composite structure is believed to decrease rapidly with volume fraction. A system, such as a bipolar device or energy storage device, has structures or components in which the diffusion length or path that electrodes or ions must traverse is minimized and the interfacial area exposed to the ions or electrons is maximized. The device includes components that can be reticulated or has a reticulated interface so that an interface area can be increased. The increased interfacial perimeter increases the available sites for reaction of ionic species. Many different reticulation patterns can be used. The aspect ratio of the reticulated features can be varied. Such bipolar devices can be fabricated by a variety of methods or procedures. A bipolar device having structures of reticulated interface can be tailored for the purposes of controlling and optimizing charge and discharge kinetics. A bipolar device having graded porosity structures can have improved transport properties because the diffusion controlling reaction kinetics can be modified. Graded porosity electrodes can be linearly or nonlinearly graded. A bipolar device having perforated structures also provides improved transport properties by removing tortuosity and reducing diffusion distance.